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Description

The invention relates to a method and apparatus for monitoring the length of sheets passing a predetermined position.

There is a requirement, particularly in the case of document counting and sorting, for example banknote counting and sorting to determine accurately the length of sheets passing a predetermined position. This determination can be used for a variety of purposes such as the detection of unacceptable sheets or to distinguish between sheets having different lengths so that they may be sorted in appropriate directions.

In the past, sheets have been fed by transport means past a predetermined position and the presence of a sheet at the predetermined postion has been sensed at regularly spaced times. A rough indication of the length of a sheet is then derived by counting the number of sensing times at which a sheet was sensed. One problem with this arrangement is that in general leading and trailing edges of a sheet will not exactly coincide with a sensing time. This means that previous systems will determine different lengths for substantially identical sheets. In some cases, this may be acceptable but particularly in the case of detecting counterfeit documents and for distinguishing between certain genuine, but different denomination, banknotes a more accurate determination of length is required.

In GB 2129126 a system is described for measuring the true width or length of a moving sheet which relies on having at least four sensors, two sensors being spaced in the feed direction of the moving sheet and two sensors being spaced in a direction transverse to the feed direction.

It should be understood that in this specification the term "length" means the dimension of a sheet in the direction of movement of the sheet. In practice, this dimension may not be the longest dimension of the sheet.

In accordance with one aspect of the present invention, a method of monitoring the length of sheets passing a predetermined position comprises

1) monitoring a relatively fast rate count at least in two pairs of intervals wherein
   a) during one interval of each pair leading and trailing edges of the sheet are sensed respectively, the count being monitored for a period during the interval related to the time at which the leading or trailing edge passes the predetermined position and during the other interval of each pair the count is monitored for the entire interval,
   b) during each interval the count is incremented at a constant rate, and
   c) the duration of the intervals is long compared with the time between successive counts;
2) determining respective total counts from the monitored counts;
3) determining first and second values related to the lengths of the portions of the sheet passing the predetermined position during the intervals in which the leading and trailing edges are sensed by comparing the total counts monitored in the intervals of each pair;
4) determining a third value related to the length of the portion of the sheet passing the predetermined position between the intervals in which the leading and trailing edges are sensed; and
5) deriving a value related to the total length of the sheet passing the predetermined position from the first, second, and third values.

The invention improves upon the prior art systems by determining values related to the length of the portions of the sheet passing the predetermined position during the intervals in which the leading and trailing edges are sensed. This enables a very accurate determination of the length of the sheet to be achieved.

It should be noted that the invention has several advantages. Firstly, the overall measurement is substantially independent of the speed of the sheet. Secondly, the measurement accuracy is independent of the speed of the count while the count rate itself defines the leading and trailing edge resolutions. Thus the faster the count rate, the greater the resolution obtained. Thirdly, the invention obviates the need for the expensive and bulky shaft encoding devices which would otherwise be necessary to achieve similar resolutions.

Although it must be assumed that the speed of the sheet during any particular interval is substantially constant, the speeds in successive intervals do not necessarily have to be the same. Preferably, however, at least during the intervals of each pair the sheet moves at the same substantially constant rate. The first and second values may then be determined simply by directly comparing the number of increments of the count in the successive intervals of each pair. This considerably simplifies the later processing steps since otherwise some additional compensation would be required.

Preferably, the intervals of each pair are successive so as to maximise accuracy by minimising the chance of significant changes in the count rate.

Conveniently, the two pairs of intervals are separated by ten to twenty different intervals. However, in

some methods each pair of intervals may share a common interval. This common interval, for which typically a total count will be determined, preferably occurs while a sheet is passing the predetermined position but it could occur outside this time.

Similarly, it is preferable if the count is monitored only when a sheet is sensed at the predetermined position. This again reduces the risk of obtaining erroneous counts which could occur when monitoring part of the sheet transport system due to differences between the feed rate when a note is present and when a note is not present.

During the interval when the leading edge of the sheet is sensed the count is preferably monitored from the detection of the leading edge to the end of the interval; similarly during the interval when the trailing edge is sensed, the count is preferably monitored from the beginning of the interval to the detection of the trailing edge. However, the count could be monitored from the time at which the trailing edge is sensed to the end of the interval and from the beginning of an interval to the time at which a leading edge is sensed. In this case these counts could be subtracted from the count for a whole interval to produce the counts required.

Typically step 5 comprises summing the first, second and third values to generate the fourth value.

Step 4 may be carried out in any conventional way but conveniently this step comprises determining the number of intervals during which the sheet moves through substantially the same distance past the predetermined position or positions. This number can then be multiplied by a constant relating to the distance of movement to provide the third value.

In order to determine the time of commencement and termination of each interval, step 1 may include the step of monitoring the rotation of a shaft of transport means controlling movement of the sheets. This may most conveniently be achieved by using a conventional slotted timing disc.

The counts which are monitored could be determined by monitoring a continuously incrementing count at appropriate times. Conveniently, however, the count is initiated at least when a leading edge of the sheet is sensed and is stopped when a trailing edge is sensed.

Furthermore, the count could be incremented at different constant rates in each interval but this would lead to more complex processing.

Preferably, the method comprises carrying out steps 1-5 at two predetermined positions laterally offset from one another relatively to the direction of movement of the sheets. By carrying out the method at two laterally offset positions it is possible to compensate for skew fed sheets.

Preferably, there are about 30 fast rate count pulses in each interval. Other numbers of fast rate count pulses are acceptable ranging from for example 10 to 50 per interval. The number depends on the distance moved by a sheet in one interval and the accuracy required.

It will be appreciated that the method according to the first aspect of the invention is particularly applicable to banknote monitoring in for example banknote counting or sorting apparatus.

In accordance with a second aspect of the present invention, apparatus for monitoring the length of sheets passing a predetermined position comprises transport means for transporting the sheets past the predetermined position; sensing means for sensing the presence of a sheet at the predetermined postion; a counter which may be incremented at a relatively fast rate; processing means for carrying out steps 1 to 5 of a method according to the first aspect of the invention; and comparison means for comparing the determined length with a reference and for providing a corresponding output signal.

The sensing means may be provided by any conventional system such as an opacity detector. Preferably, however, the sensing means comprises a detector for detecting the passage of a sheet through a nip between a pair of rollers. An example of a suitable arrangement is illustrated in our copending European patent application No.0130824.

In order that the invention may be better understood, an embodiment of a banknote feeding system for carrying out methods according to the invention will now be described with reference to the accompanying drawings; in which:-

Figure 1 is a schematic view of the sensing system of the apparatus partly in block diagram form;

Figure 2 is a pulse diagram illustrating output signals from the sensing system illustrated in Figure 1;

Figure 3 is a signal diagram illustrating the variation in duration of counter enabling signals due to different thickness banknotes; and

Figure 4 is a flow diagram illustrating some of the steps carried out by the controlling microprocessor.

The sensing system shown in Figure 1 comprises two pairs of rollers 1, 2. The rollers 1 are non-rotatably mounted on a shaft 3, while the rollers 4 are rotatably mounted on a shaft 4. The rollers 1, 2 form part of a transport system (not shown) for transporting single sheets from a hopper to a stacking position in order to count the number of sheets in the hopper. An example of such a counting system is described in more detail in our copending European patent application mentioned above and is incorporated in the De La

Rue 2300 banknote counting machine. Each pair of rollers 1, 2 defines a respective nip 5, 6. A slotted timing wheel 7 of conventional form is non-rotatably mounted to an extension of the shaft 3. The slots 8 of the wheel 7 are equally, circumferentially spaced around the wheel 7 and the light emitting diode and transistor of a detector 9 are positioned on either side of the wheel 7. Output signals (C) from the detector 9 are fed to a microprocessor 10 such as an INTEL 8040.

When a banknote enters the nips 5, 6 this will cause radial movement of rotatable portions 11 of the rollers 2. This movement will be detected by detectors 12 mounted in the shaft 4 each of which provides a corresponding output signal which is fed to amplifiers 13, 14 respectively. The output signals (A,B) from the amplifiers 13, 14 are fed to enabling inputs of respective counters 15, 16. An oscillator 17 generates a substantially constant high pulse rate output signal (eg. 21MHz) which is fed to each of the counters 15, 16. When the counters 15, 16 are enabled by the respective signals A, B, they are incremented at the rate of the pulse signal from the oscillator 17.

When no sheet is present in the nips 5, 6 first signals are output from the detectors 12 and fed to the amplifiers 13, 14. When a banknote enters the nips 5, 6 the detectors 12 issue a second signal (which may in certain cases have zero amplitude) which enables the respective counters 15, 16. It should be understood that the amplifiers 13, 14 are chosen to be suitable for causing the respective counters 15, 16 to be enabled when a sheet is detected.

Figure 2 illustrates the case where a banknote is fed slightly skew to the feed direction so that a leading edge of the banknote reaches the nip 6 before the nip 5 is reached. For the sake of example, the situation relative to the nip 5 will be described in more detail. As soon as a banknote is detected in the nip 5 an appropriate signal is fed via the amplifier 14 to the counter 16 to enable the counter. This is indicated by the vertical line 18 in Figure 2. The counter 16, which has previously been reset to zero, then starts to count pulses received from the oscillator 17.

At the same time, as the rollers 2 rotate, periodic signals (C) are output from the detector 9 to the microprocessor 10 at a rate for example of 700 per second. These signals will relate to the time intervals during which the rollers 2 have rotated through a fixed angle corresponding to movement of the note through a distance of typically 4.7 mm. Since the slots 8 of the timing wheel 7 are equally spaced this will correspond to equal angles of rotation. (Unequal spacing could also be used with more complex processing). It should be noted that the signals from the detector 9 may not be equally spaced in time if the rollers 2 do not rotate at a constant rate but substantially equal units of length will be transported through the nips between each pair of slots. For convenience, successive signals from the detector 9 over the period concerned are labelled M-V respectively in Figure 2. In practice a much larger number of intervals will occur between the passage of leading and trailing edges in the order 10-20. It should be noted that the pulse rate delivered by the oscillator 17 is considerably higher than the rate of pulses from the detector 9.

As has previously been explained, as soon as the counter 16 is enabled it starts to count pulses from the oscillator 17. Thus, at the time P the microprocessor 10 will derive a count value front the counter 16 (and also the counter 15). At this time, the microprocessor 10 also causes the counters 15, 16 to be reset. At the next signal from the detector 9 (Q) the counters 15, 16 are again read (and reset) to determine second count values. It is assumed that the feed rate of the banknote in these two time intervals ending at P and Q is the same so that simply by taking the ratio of the counts read from the counter 16 it is possible to determine what proportion of the interval O-P corresponded to the presence of a note in the nip 5.

At successive signals from the detector 9, the microprocessor 10 reads the counts from the counters 15, 16 and then resets the counters for the next interval. After the signal at time T, the trailing edge of the banknote passes through the nip 5 and the signal B from the appropriate detector 12 changes, as indicated by line 19 in Figure 2, to disable the counter 16. At the time U, the microprocessor 10 reads the count in the counter 16 which will be much smaller than for a fully counted interval such as Q-R. Again, by determining the proportion of the count determined at the time U with the count determined at the time T a value related to the length of the final portion of the note can be determined.

Since the occurrence of signals Q, R, S and T corresponds to the passage of a certain length of sheet it is a simple matter to determine the full length of the sheet. For example if there are X intervals during the whole of which a sheet remains in the appropriate nip then the total length of the sheet may be represented by a value given by the formula:

$$(P/Q + X + U/T)$$

where in this particular example $X = 4$ and P, Q, U, T represent the counts determined at the end of these intervals. This value can be used as it stands or converted to an actual length if the rotation distance of the roller 11 between successive signals from the detector 9 is known.

The length measurement described above can vary by a small amount in accordance with the thickness of the note being fed. Figure 3 illustrates two examples of the output signal 20, 21 due to the passage of a relatively thin note and a relatively thick note respectively. The presence of a note in the nip is determined by comparing these output signals 20, 21 with a threshold 22 so that a note is only detected when this minimum threshold 22 is exceeded. However, it will be seen that the signal 20 due to a thin note takes longer to exceed the threshold 22 than the signal 21 corresponding to a thick note. This means that the counter enabling signals Y_1, Y_2 (equivalent to signals A, B in Figures 1 and 2) will be generated at different times, as can be seen in Figure 3, depending upon the thickness of a note. This is, in certain circumstances, undesirable since it will lead to an error in the determination of the length of the note.

To compensate for thickness, it is therefore preferred that the microprocessor 10 reduces the calculated length of a banknote having a thickness greater than some minimum thickness, say due to a minimum thickness banknote, in accordance with the following formula:

$$\text{Compensated length} = \text{Measured length} - T_n/K$$

where T_n is representative of the thickness of the sheet as determined by the signals from the detector and will lie between certain minimum and maximum thickness values. K is chosen to ensure that the units of T_n/K correspond to the units of "measured length".

In a typical example, the minimum thickness of a sheet which is allowable may be 20 while the maximum allowable thickness is 60, T_n lying between these values and being typically 25. In this example, K is chosen to be 10.

The values of T_n and K depend on the processing equipment used and K is chosen empirically.

In the case shown in Figure 2, the banknote is skew fed and this can be compensated for by using a formula of the form:

$$\text{True length} = \text{Calculated length} \times \text{Cosine}\left(\text{Arctangent}\left(\frac{Ls}{Ld}\right)\right)$$

<u>OR</u>

$$\text{True length} = \text{Calculated length} \times \frac{Ld}{\sqrt{Ld^2 + Ls^2}}$$

where Ld = distance between detectors 12 being typically 60 mm.
and Ls = length of skew measurement between left and right detectors 12.

The microprocessor 10 is used to calculate the true length. Note that the true length equals the calculated length when the skew measurement is zero.

An alternative method for determining the acceptability of banknotes will now be described. In this method, the apparatus shown in Figure 1 is again used but the microprocessor 10 determines the length of the banknote as separately detected by each detector 12. These lengths L_1, L_2 are then processed in the following manner.

Figure 4 is a flow diagram illustrating part of the operation of the microprocessor.

After the two note lengths L_1, L_2 have been determined 23, the difference between the two lengths is calculated 24. This difference is then compared with a preset threshold D in a step 25. Typically, in the case of banknotes, D may be set to about 10 mm.

If the difference between the measured note length is greater than D, step 26, this is taken to indicate a banknote part of which is torn, cut, or folded and the like. However, such a banknote may still be a genuine banknote and the method set out in Figure 4 provides a way in which the banknote may be accepted despite this apparent difference in note length.

In a step 27 the measured length L_1 is compared with an allowable range of lengths which may be defined in terms of a nominal length and a tolerance or, preferably, by upper and lower values. These values may have been preset or previously determined from the first sheet of a batch which is fed through the note counter.

An example of suitable maximum and minimum length limits is 68 mm and 62 mm respectively.

If L_1 is found to lie within the allowable range, the microprocessor 10 generates an acceptance signal 28 which may be used to increment a running total of a counter.

If L_1 is found not to lie within the allowable range, L_2 is compared with the allowable range 29 and a similar acceptance signal is generated if L_2 is found to lie within the range.

If, however, both L_1 and L_2 lie outside the allowable range then a reject signal is generated 30 by the microprocessor 10. This may be used, for example, to stop the machine to enable the unacceptable note to be extracted.

If, in step 26, the difference between the measured length is found to be less than or equal to the threshold D, the average of the two lengths is determined, 31. This is because the difference may be due to a genuine sheet being fed slightly askew.

The average measured length is then compared with the same allowable range used in steps 27 to 29, in a step 32. If the average is found to lie within the range then the general acceptance signal 28 is generated while if it is outside the range, the reject signal is generated.

Of course, it should be understood that additional tests may be carried out on the banknotes as they are fed so that although the length may be determined to be acceptable, the banknote may still be judged not to be genuine if it fails for example an opacity test.

Claims

1. A method of monitoring the length of sheets passing a predetermined position (5,6), the method comprising
   1) monitoring a relatively fast rate count at least in two pairs of intervals wherein
      a) during one interval of each pair leading and trailing edges of the sheet are sensed respectively, the count being monitored for a period during the interval related to the time at which the leading or trailing edge passes the predetermined position (5,6), and during the other interval of each pair the count is monitored for the entire interval,
      b) during each interval the count is incremented at a constant rate, and
      c) the duration of the intervals is long compared with the time between successive counts;
   2) determining respective total counts from the monitored counts;
   3) determining first and second values related to the lengths of the portions of the sheet passing the predetermined position (5,6) during the intervals in which the leading and trailing edges are sensed by comparing the total counts monitored in the intervals of each pair;
   4) determining a third value related to the length of the portion of the sheet passing the predetermined position (5,6) between the intervals in which the leading and trailing edges are sensed; and
   5) deriving a value related to the total length of the sheet passing the predetermined position (5,6) from the first, second, and third values.

2. A method according to claim 1, wherein step 4 comprises determining the number of intervals during which the sheet moves through substantially the same distance past the predetermined position (5,6).

3. A method according to claim 1 or claim 2, wherein the two pairs of intervals are separated by ten to twenty different intervals.

4. A method according to any of the preceding claims, wherein the count is monitored only when a sheet is sensed at the predetermined position (5,6).

5. A method according to claim 4, wherein the count is initiated at least when a leading edge of the sheet is sensed and is stopped when a trailing edge is sensed.

6. A method according to any of the preceding claims, wherein step 1 includes the step of monitoring the rotation of a shaft (3) of transport means (1,2) controlling movement of the sheets, and generating a timing signal after equal rotations of the shaft.

7. A method according to any of the preceding claims, wherein step 5 comprises summing the first, second and third values to generate the fourth value.

8. A method according to any of the preceding claims, wherein there are about 30 fast rate count pulses in each interval.

9. A method according to any of the preceding claims, further comprising carrying out steps 1-5 at two predetermined postions (5,6) laterally offset from one another relatively to the direction of movement of the sheets.

10. Apparatus for monitoring the length of sheets passing a predetermined position (5,6), the apparatus comprising transport means (1,2) for transporting the sheets past the predetermined position (5,6); sensing means (9) for sensing the presence of a sheet at the predetermined postion (5,6); a counter (15,16) which may be incremented at a relatively fast rate; processing means (10) for carrying out steps 1 to 5 of a method according to any of the preceding claims; and comparison means for comparing the determined length with a reference and for providing a corresponding output signal.

11. Apparatus according to claim 10, wherein the transport means (1,2) includes a shaft (3) which is rotatable to control movement of the sheets, the sensing means comprising a slotted timing disc (7) non-rotatably mounted to the shaft (3) and detection means (9) fixed relatively to the timing disc for sensing the movement of slots (8) past the sensing means (9) and for generating suitable output signals.

12. Apparatus according to claim 11, wherein the output signals generated by the detection means zero the counter.

13. Apparatus according to any of claims 10 to 12, wherein the counter (15,16) is enabled by the sensing means (9) when the leading edge of a sheet is sensed and disabled when the trailing edge of a sheet is sensed.

14. A system for monitoring the length of sheets passing two laterally spaced positions, the system comprising two sets of apparatus according to any of claims 10 to 13, the processing means and comparison means being common to both apparatus.

15. A method of monitoring the length of banknotes according to any of claims 1 to 9.

Revendications

1. Méthode de contrôle de la longueur de feuilles passant par un point prédéterminé (5,6), ladite méthode comportant
   (1) le contrôle d'un régime de comptage qui s'avère relativement rapide au minimum en deux paires d'intervalles, suivant lequel
      (a) lors d'un intervalle de la paire les bords d'attaque et de fuite de la feuille respectivement sont captés, le comptage étant contrôlé dans l'intervalle pour un délai se rapportant au moment de passage du point (5,6) prédéterminé par le bord d'attaque ou de fuite, le comptage étant contrôlé lors de l'intervalle entier de l'autre paire,
      (b) le comptage est augmenté selon un régime constant pour chaque intervalle, et
      (c) la durée des intervalles est longue comparée au délai entre comptages successifs;
   (2) la définition des comptages respectifs globaux à partir des comptages contrôlés;
   (3) la définition de premières et deuxièmes valeurs se rapportant à la longueur des portions de feuille passant le point prédéterminé (5,6) lors des intervalles pendant lesquels les bords d'attaque et de fuite sont captés par comparaison de comptages globaux contrôlés pour les intervalles de chaque paire;
   (4) la définition d'une troisième valeur ayant trait à la longueur de la portion de feuille passant par le point prédéterminé (5,6) entre les intervalles dans lesquels les bords d'attaque et de fuite sont captés; et
   (5) l'obtention à partir des première, deuxième et troisième valeurs d'une valeur se rapportant à la longueur globale de feuille passant par le point prédéterminé (5,6).

2. Méthode selon la revendication 1 ou 2, dont la phase 4 comporte la détermination du nombre d'intervalles lors desquels la feuille se déplace effectivement de la même distance au delà de la position prédéterminée (5,6).

3. Méthode selon les revendications 1 ou 2, suivant laquelle les deux paires d'intervalles sont séparées de

dix ou vingt intervalles différents.

4. Méthode selon l'une quelconque des revendications précédentes, suivant laquelle le comptage est contrôlé exclusivement lorsqu'un feuillard est capté au point prédéterminé (5,6).

5. Méthode selon la revendication 4, suivant laquelle le comptage est lancé au minimum suite au captage du bord d'attaque de feuille et interrompu au captage du bord de fuite.

6. Méthode selon l'une quelconque des revendications précédentes, suivant laquelle la phase 1 comporte la phase de contrôle de la rotation d'un axe (3) de moyens de transport (1,2) assurant la commande du mouvement des feuilles, et la génération d'un signal de minutage après chaque rotation égale de l'axe.

7. Méthode selon l'une quelconque des revendications précédentes, suivant laquelle la phase 5 comporte l'addition des première, deuxième et troisième valeurs pour générer la quatrième valeur.

8. Méthode selon l'une quelconque des revendications précédentes, suivant laquelle chaque intervalle comporte environ 30 impulsions de comptage en régime rapide.

9. Méthode selon l'une quelconque des revendications précédentes, comportant également la mise en oeuvre des phases 1-5 en deux positions prédéterminées (5,6) et en décalage latéral réciproque par rapport au sens de mouvement des feuilles.

10. Appareil de contrôle de la longueur de feuilles passant par un point prédéterminé (5,6), ledit appareil comportant des moyens de transport (1,2) effectuant le transport des feuilles en passant par le point prédéterminé (5,6); des moyens capteurs (9) de captage de présence d'une feuille au point prédéterminé (5,6); un compteur admettant l'incrémentation selon un régime relativement rapide; des moyens de traitement (10) de mise en oeuvre des phases 1 à 5 d'une méthode selon l'une des revendications précédentes; et des moyens de comparaison avec un repère de la longueur déterminée et offrant un signal correspondant de sortie.

11. Appareil selon la revendication 10, dont les moyens de transport (1,2) prévoient un axe (3) admettant la rotation pour régler le mouvement des feuilles, les moyens de captage comportant un disque de minuterie à fentes (7) monté fixe sur l'axe (3) et des moyens de captage (9) montés relativement au disque de minuterie pour capter le mouvement des fentes (8) passant par les moyens de captage (9) et pour générer des signaux correspondants de sortie.

12. Appareil selon la revendication 11, dont les signaux de sortie générés par les moyens de captage assurent la remise à zéro du compteur.

13. Appareil selon l'une ou l'autre des revendications 10 à 12, selon lequel le compteur (15,16) est validé par les moyens de captage (9) lorsque le bord d'attaque de la feuille est capté et invalidé lorsque le bord de fuite de la feuille est capté.

14. Système de contrôle de longueur de feuilles passant par deux points prévus à distance latérale, le système ayant deux jeux d'appareils selon l'une ou l'autre des revendications 10 à 13, les moyens communs de traitement et de comparaison étant prévus pour les deux appareils.

15. Méthode de contrôle de longueur des billets de banque selon l'une ou l'autre des revendications 1 à 9.

Patentansprüche

1. Verfahren zum Überwachen der Länge von Blättern, die eine vorbestimmte Stelle (5,6) passieren, wobei das Verfahren folgendes umfasst:
   1) Überwachen einer relativ schnellen Zählungsrate wenigstens in zwei Paaren von Intervallen, in dem
      a) während eines Intervalls von jedem Paar jeweils Vorder- und Hinterkanten des Blattes abgetastet werden, die Zählung für einige Zeit während des Intervalls überwacht wird, das auf die Zeit bezogen ist, bei der die Vorder- oder Hinterkante die vorbestimmte Stelle (5,6) passiert, und

während des anderen Intervalls von jedem Paar die Zählung für das ganze Intervall überwacht wird,
b) die Zählung während jeden Intervalls konstant vergrössert wird, und
c) die Dauer der Intervalle verglichen mit der Zeit zwischen aufeinanderfolgenden Zählungen lang ist;
2) Bestimmen entsprechender Gesamtzählungen von den überwachten Zählungen;
3) Bestimmen erster und zweiter Werte, die sich auf die Längen der Teile der Blätter beziehen, die die vorbestimmten Stellen (5,6) während der Intervalle passieren, in denen Vorder- und Hinterkanten abgetastet werden, indem die in den Intervallen jeden Paares überwachten Gesamtzählungen verglichen werden;
4) Bestimmen eines dritten Wertes, der sich auf die Länge des Teils des Blattes bezieht, das die vorbestimmte Stelle (5,6) zwischen den Intervallen, in denen Vorder- und Hinterkanten abgetastet werden, passiert;
5) Ableiten eines Wertes, der sich auf die Gesamtlänge des Blattes bezieht, das die vorbestimmte Stelle (5,6) passiert, von den ersten, zweiten und dritten Werten.

2. Verfahren nach Anspruch 1, in dem Schritt 4 umfasst, die Anzahl von Intervallen, während denen das Blatt sich durch im wesentlichen dieselbe Entfernung an der vorbestimmten Stelle (5,6) vorbei bewegt, zu bestimmen.

3. Verfahren nach Anspruch 1 oder Anspruch 2, in dem die zwei Paare von Intervallen durch zehn bis zwanzig verschiedene Intervalle getrennt werden.

4. Verfahren nach einem der vorhergehenden Ansprüche, in dem die Zählung nur überwacht wird, wenn ein Blatt an der vorbestimmten Stelle (5,6) abgetastet wird.

5. Verfahren nach Anspruch 4, in dem die Zählung wenigstens angefangen wird, wenn eine Vorderkante des Blattes abgetastet wird, und beendet wird, wenn eine Hinterkante abgetastet wird.

6. Verfahren nach einem der vorhergehenden Ansprüche, in dem Schritt 1 den Schritt einschliesst, die Drehung einer Welle (3) eines Transportmittels (1,2) zu überwachen, die die Bewegung der Blätter kontrolliert, und ein Zeitmessungssignal nach gleichen Drehungen der Welle zu erzeugen.

7. Verfahren nach einem der vorhergehenden Ansprüche, in dem Schritt 5 umfasst, die ersten, zweiten und dritten Werte zu addieren, um den vierten Wert zu erzeugen.

8. Verfahren nach einem der vorhergehenden Ansprüche, in dem in jedem Intervall ungefähr 30 schnelle Zählungsgeschwindigkeitsimpulse vorhanden sind.

9. Verfahren nach einem der vorhergehenden Ansprüche, das weiterhin umfasst, Schritte 1-5 an zwei vorbestimmten Stellen (5,6), die lateral voneinander relativ zur Bewegungsrichtung der Blätter versetzt sind, durchzuführen.

10. Vorrichtung zum Überwachen der Länge von Blättern, die eine vorbestimmte Stelle (5,6) passieren, wobei die Vorrichtung ein Transportmittel (1,2) umfasst, um die Blätter über die vorbestimmten Stellen (5,6) hinaus zu transportieren; ein Abtastmittel (9) zum Abtasten des Vorhandenseins eines Blattes an der vorbestimmten Stelle (5,6); einen Zähler (15,16), der relativ schnell erhöht werden kann; ein Verarbeitungsmittel (10), um Schritte 1 bis 5 eines Verfahrens nach einem der vorhergehenden Ansprüche durchzuführen; und ein Vergleichsmittel, um die bestimmte Länge mit einem Bezugswert zu vergleichen, und um ein entsprechendes Ausgangssignal zu liefern.

11. Vorrichtung nach Anspruch 10, in der das Transportmittel (1,2) eine Welle (3) einschliesst, die drehbar ist, um die Bewegung der Blätter zu kontrollieren, wobei das Abtastmittel eine Zeitmessungsscheibe (7) mit Spalten umfasst, die nicht drehbar an der Welle (3) angebracht ist, und ein Nachweismittel (9), das relativ an der Zeitmessungsscheibe befestigt ist, um die Bewegung der Spalten (8) über das Abtastmittel (9) hinaus abzutasten, und um geeignete Ausgangssignale zu erzeugen.

12. Vorrichtung nach Anspruch 11, in der die von dem Nachweismittel erzeugten Ausgangssignale den

Zähler auf Null einstellen.

13. Vorrichtung nach einem der Ansprüche 10 bis 12, in der der Zähler (15,16) durch Abtastmittel (9) in Stand gesetzt wird, wenn die Vorderkante eines Blattes abgetastet wird, und ausserstand gesetzt wird, wenn die Hinterkante eines Blattes abgetastet wird.

14. System zum Überwachen der Länge von Blättern, die zwei lateral voneinander beabstandete Stellen passieren, wobei das System zwei Sätze von Vorrichtungen nach einem der Ansprüche 10 bis 13 umfasst, wobei das Verarbeitungsmittel und das Vergleichsmittel beiden Vorrichtungen gemein sind.

15. Verfahren zum Überwachen der Länge von Banknoten nach einem der Ansprüche 1 bis 9.

Fig.1.

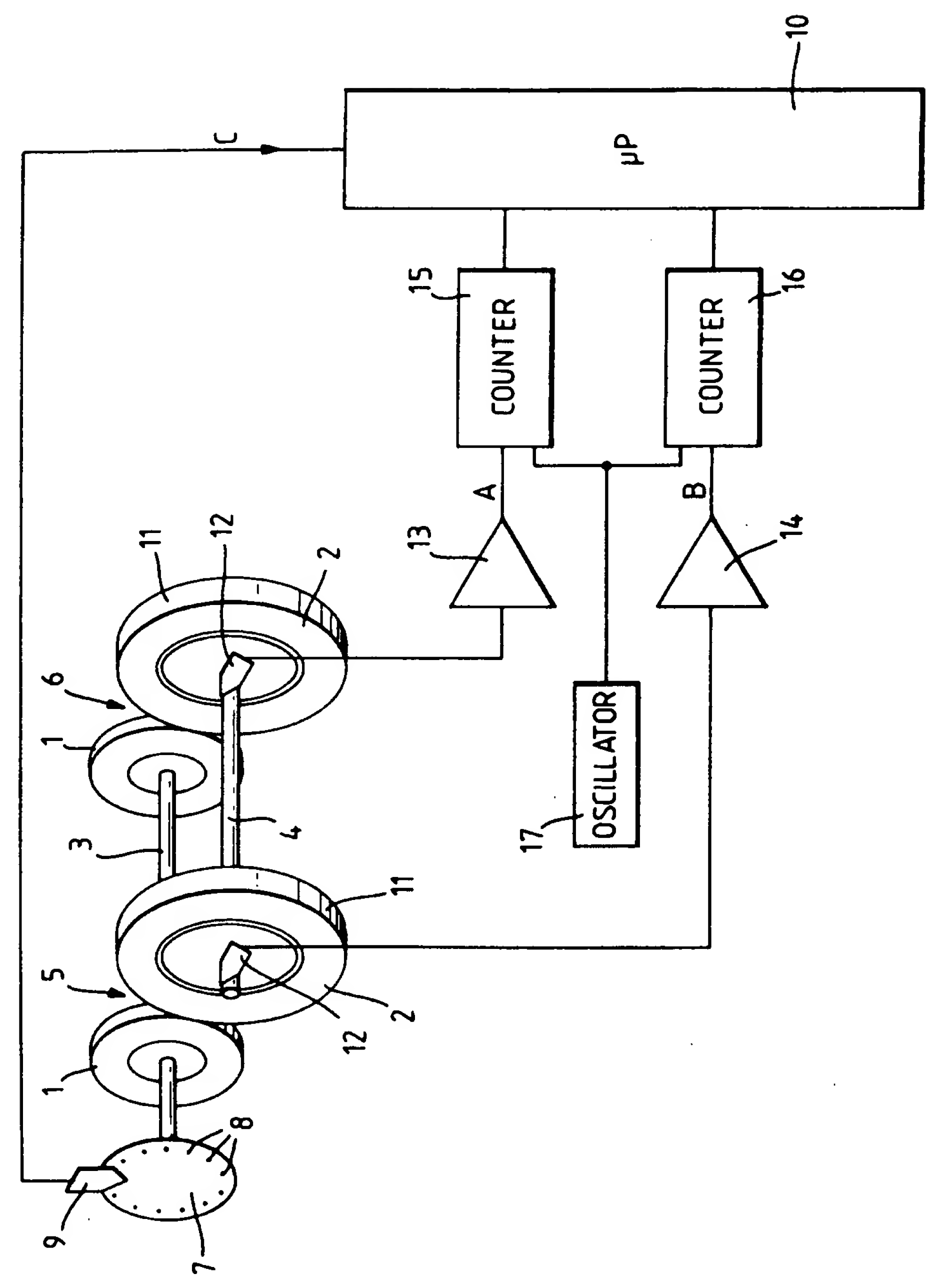

µP
COUNTER
COUNTER
OSCILLATOR
A
B
C
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

Fig. 2.

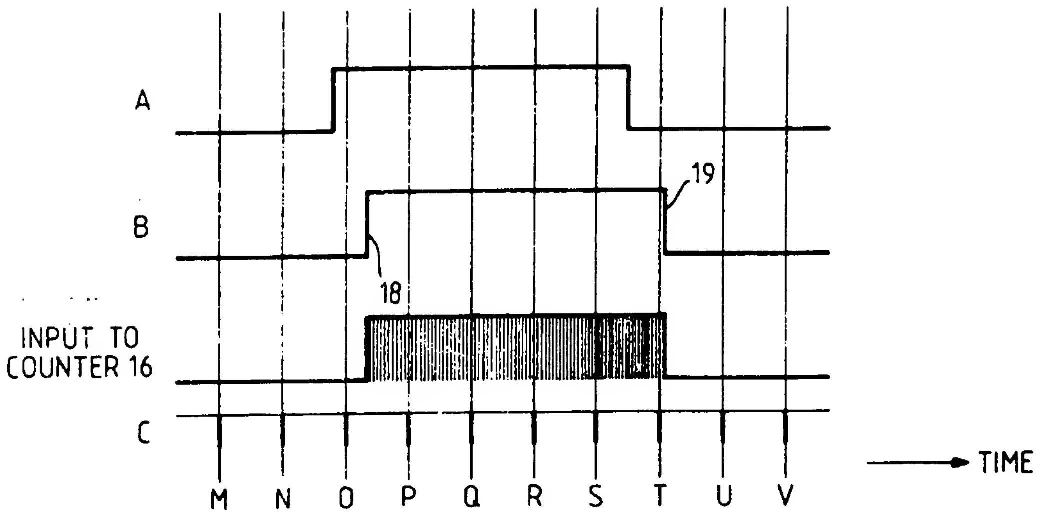

A
B
19
18
INPUT TO
COUNTER 16
C
M
N
O
P
Q
R
S
T
U
V
TIME

Fig. 3.

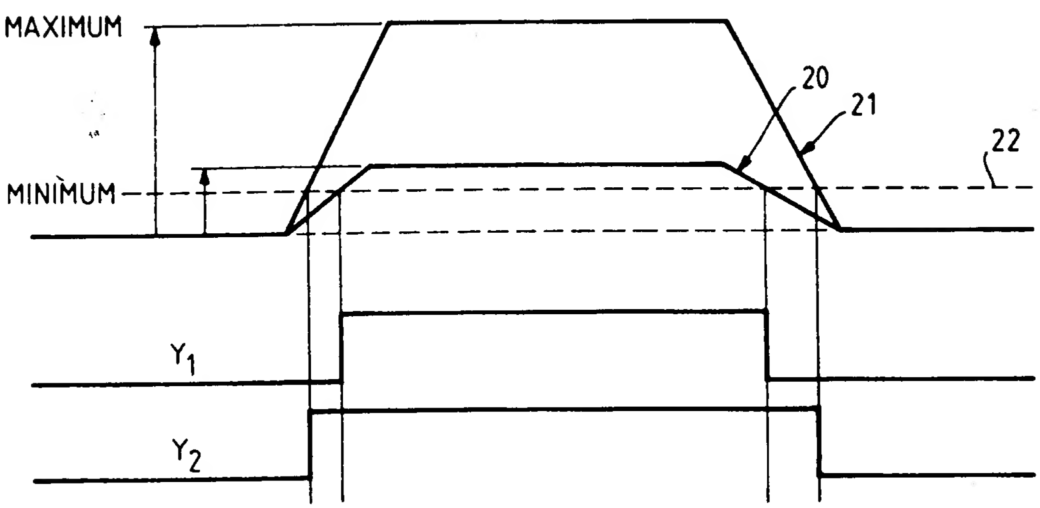
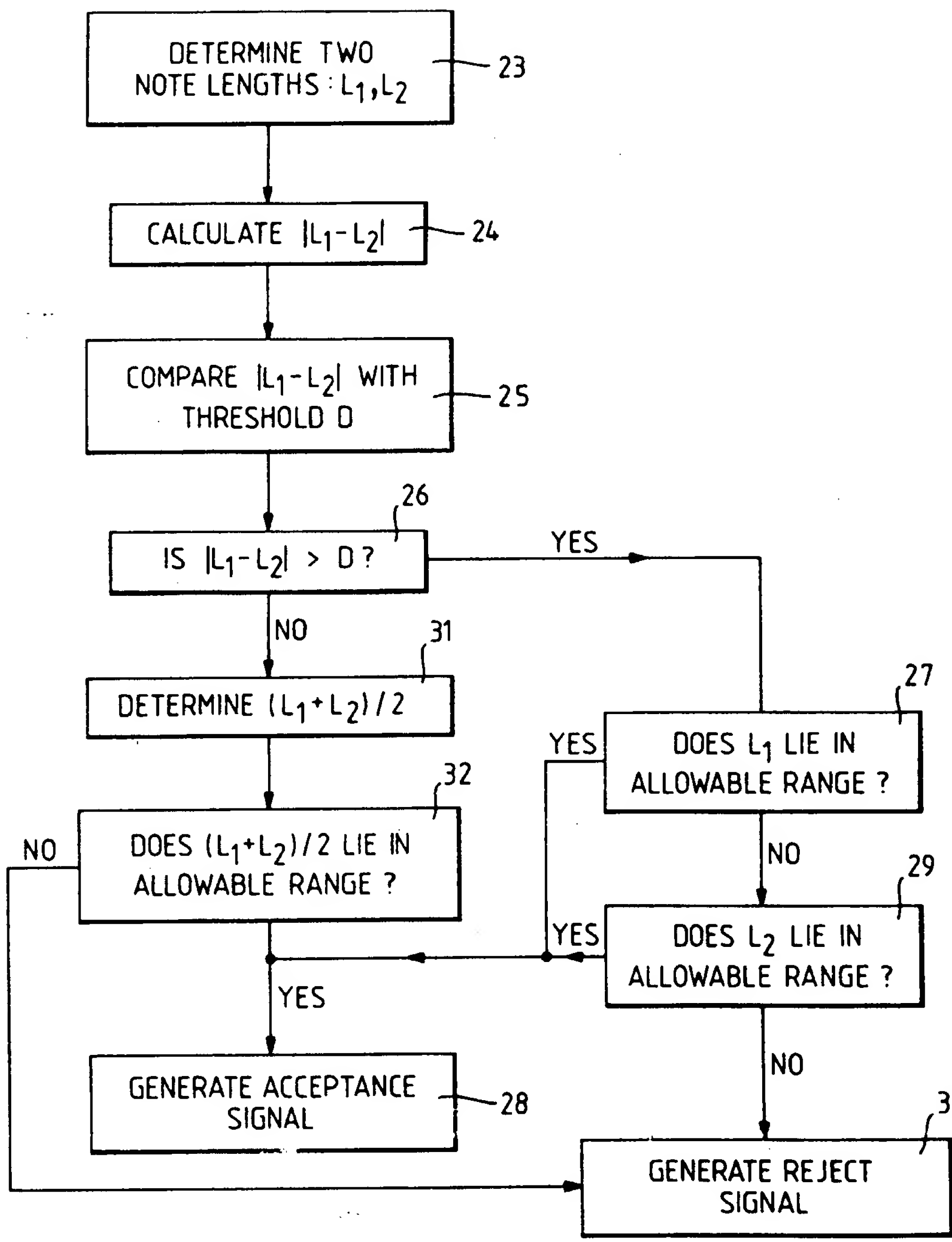

MAXIMUM
MINIMUM
20
21
22
Y_1
Y_2

Fig. 4.


DETERMINE TWO NOTE LENGTHS : L1,L2
23
CALCULATE |L1-L2|
24
COMPARE |L1-L2| WITH THRESHOLD D
25
26
IS |L1-L2| > D ?
YES
NO
31
DETERMINE (L1+L2)/2
27
DOES L1 LIE IN ALLOWABLE RANGE ?
YES
32
NO
DOES (L1+L2)/2 LIE IN ALLOWABLE RANGE ?
NO
29
YES
DOES L2 LIE IN ALLOWABLE RANGE ?
YES
NO
30
GENERATE ACCEPTANCE SIGNAL
28
GENERATE REJECT SIGNAL